Advanced InkJet Printing Technology for Trace Explosives Standards

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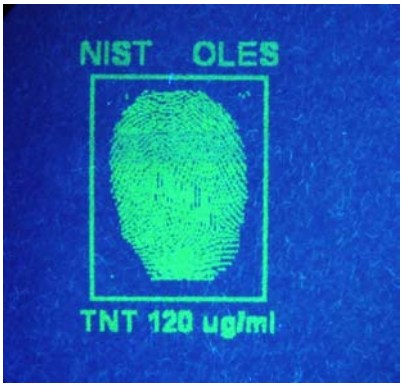
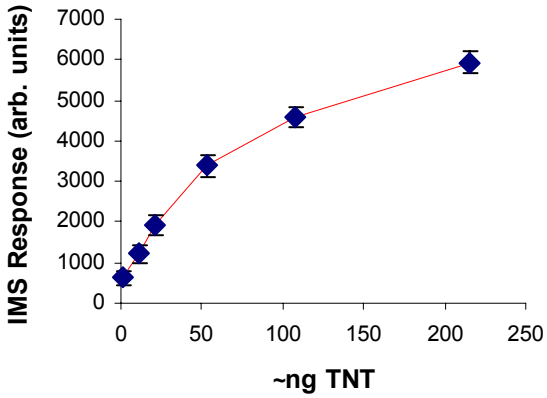
Vision: Current national priorities in homeland security have led to an unprecedented level of utilization of trace explosive detection systems for counter terrorism and law enforcement. A critical and immediate need is to develop a chemical metrology and standards infrastructure to support the widespread operational deployment of tabletop, handheld and portal- based trace explosive detection systems now being used in airports, military installations and in law enforcement applications.

Purpose: The purpose of this effort is to develop prototype standard reference materials for calibration and optimization of trace explosive detection instruments. We are exploring drop-on-demand inkjet printing as a low cost, flexible and reproducible method for preparation of explosive standards over a wide range of concentrations on almost any substrate.



Inkjet printed fingerprint containing TNT and fluorescent dye



IMS response curve for TNT standard inkjet printed directly on collection swipe

Major accomplishments: A new piezoelectric inkjet printer system at NIST has been used to prepare prototype explosive standard reference materials on a variety of substrates. Inkjet printing potentially offers a flexible, rapid and reproducible method for preparation of explosive standards. Using a single standard solution, a large range (10^6) in deposited quantity of explosive can be achieved by changing the number of drops delivered to the sample without the need for serial dilutions. Using four printheads allows mixtures of virtually any composition to be prepared. The NIST printer system has been used to prepare prototype calibration standards by drop-on-demand printing of RDX, PETN and TNT from isobutanol solutions onto various substrates. The concentration of explosives delivered in individual inkjet droplets is determined by GC-MS analysis or by determination of droplet diameter using digital camera imaging with high frequency strobe illumination. A second sample type involves printing of digitized human fingerprints using RDX or TNT as the printing media. To visualize the location of the fingerprint, a fluorescent dye is co-jetted with the explosives.

Future Work:

We are working to improve the quantitative delivery of solution using inkjet printing. The NIST printer system is being modified to use optical particle counting for real-time evaluation of the number of drops ejected and the individual droplet size. The next phase of the project will be to print explosives containing polymers to more accurately simulate actual high explosive materials.